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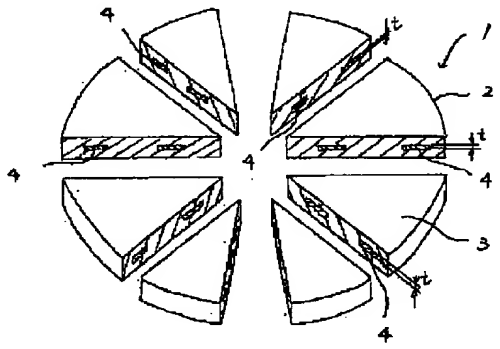
(54) CERAMIC HEATER AND ITS MANUFACTURE

(57) Abstract:

PROBLEM TO BE SOLVED: To provide a ceramic heater in which temperature is uniformly distributed on a heating surface by minimizing a thickness dispersion of a resistance heating element embedded in a ceramic body.

SOLUTION: A green sheet for a resistance heating element is produced by a tape forming method by adding solvent and binder to metal with a high fusing point, its alloy or conductive ceramics powder and kneading them, and after forming a green sheet laminated body by inserting a piece blanked out to a designated heating pattern by a die between the green sheets to compose a ceramic body, it is degreased, and is then baked. A heating pattern in which a difference between the maximum value and the minimum value of a thickness (t) of each heating element 4 in a cutting plane cut by at least two line segments passing through an almost center point in a heating pattern region composed by a band shaped resistance heater element 4 is not more than 10% of an average thickness value of the resistance heating element 4 in all cutting planes, is embedded in a flat ceramic body 2 in order to compose a ceramic heater 1.



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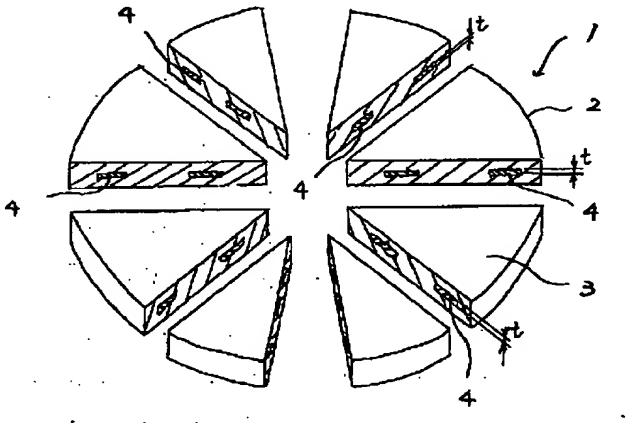
(54)【発明の名称】　セラミックヒータ及びその製造方法

(57)【要約】

【課題】セラミック体２中に埋設してある抵抗発熱体３の厚みばらつきを極めて小さくすることにより発熱面における温度分布が均一なセラミックヒータ１を提供する。

【解決手段】高融点金属やそれらの合金あるいは導電性セラミックスの粉末に溶媒とバインダーを添加混練してテープ成形法により抵抗発熱体用のグリーンシートを製作し、金型により所定の発熱パターンに打ち抜いたものをセラミック体を構成するセラミックグリーンシート間に挟み込んでグリーンシート積層体を形成したあと脱脂し、次いで焼成することにより、帯状の抵抗発熱体４により構成される発熱パターン領域のほぼ中心点を通る少なくとも２本の線分により切断した切断面における各抵抗発熱体４の厚みｔの最大値と最小値の差が、全切断面における抵抗発熱体４厚みの平均値の１０％以下である発熱パターンを平板状のセラミック体２中に埋設してセラミックヒータ１を構成する。



1

【特許請求の範囲】

【請求項１】帯状の抵抗発熱体により構成される発熱パターン領域のほぼ中心点を通る少なくとも２本の線分により切断した切断面に現れる各抵抗発熱体の厚みの最大値と最小値の差が、全切断面に現れる抵抗発熱体厚みの平均値の１０％以内である発熱パターンを平板状のセラミック体中に埋設してなるセラミックヒータ。

【請求項２】上記セラミック体が窒化アルミニウム質セラミックスである請求項１に記載のセラミックヒータ。

【請求項３】セラミック体を構成する複数枚のセラミックグリーンシートを製作する工程と、高融点金属やそれらの合金あるいは導電性セラミックスの粉末に溶媒とバインダーを添加混練してテープ成形法により抵抗発熱体用のグリーンシートを製作する工程と、該抵抗発熱体用のグリーンシートを上記セラミックグリーンシートの少なくとも１枚に積層し、金型により所定の発熱パターンに打ち抜く工程と、該所定の発熱パターンに打ち抜いた抵抗発熱体用のグリーンシートを覆うように残りのセラミックグリーンシートを積層してグリーンシート積層体を形成する工程と、該グリーンシート積層体を脱脂し、しかるのち焼成する工程とからなるセラミックヒータの製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、セラミック体中に帯状の抵抗発熱体により構成される発熱パターンを有するセラミックヒータに関するものであり、例えば、各種燃焼機器の点火用ヒータ、各種加熱機器や測定機器の加熱用ヒータとして使用されるものであり、特に、半導体装置の製造工程におけるプラズマＣＶＤ、減圧ＣＶＤ、光ＣＶＤ、ＰＶＤなどの成膜装置やプラズマエッチング、光エッチングなどのエッチング装置に使用される半導体ウエハを加熱するための加熱用ヒータとして好適なものである。

【０００２】

【従来の技術】従来、セラミックヒータとしてアルミナセラミックスや窒化珪素質セラミックスなどのセラミック体中にタングステン（Ｗ）やモリブデン（Ｍｏ）などの高融点金属やＴｉＮなどの導電性セラミックスよりなる抵抗発熱体を埋設したものが知られており、これらのセラミックヒータは、耐熱性、電気絶縁性、耐食性、耐摩耗性に優れることから一般的に広く使用されている。

【０００３】また、近年、特殊な用途向けとして窒化アルミニウム質セラミックスを用いたセラミックヒータも提案されている。

【０００４】例えば、半導体装置の製造工程で使用されるプラズマＣＶＤ、減圧ＣＶＤ、光ＣＶＤ、ＰＶＤなどの成膜装置や、プラズマエッチング、光エッチングなどのエッチング装置においては、被加熱物である半導体ウエハ（以下、ウエハと称す。

2

【０００５】）を支持しつつ各種処理温度に加熱するための加熱用ヒータとして上記セラミックヒータが使用されており、その中も成膜装置やエッチング装置で使用されるフッ素系や塩素系等のハロゲン系腐食性ガス下で優れた耐プラズマ性を有するとともに高熱伝導特性を備えた窒化アルミニウム質セラミックスを用いたものが注目されている。

【０００６】このようなセラミックヒータを製造する方法としては、まず、セラミック体を構成する複数枚のセラミックグリーンシートを用意するとともに、セラミック体中に埋設する抵抗発熱体として、高融点金属や導電性セラミックスの粉末に溶媒とバインダーをそれぞれ添加混練して抵抗発熱体用の導体ペーストを製作し、この導体ペーストを所定の発熱パターンとなるようにスクリーン印刷法などの手法によって前記セラミックグリーンシートの１枚に敷設し、この導体ペーストを覆うように残りのセラミックグリーンシートを積層してグリーンシート積層体を形成したあと、脱脂し、次に所定の温度にて焼成することにより帯状の抵抗発熱体からなる発熱パターンを埋設してなるセラミック体を製作し、しかるのち、上記発熱パターンの一部を露出させ、そこにロウ材を用いて給電端子を接合することによりセラミックヒータを製造するようにしたものがあった（特公平８－３４１２３号公報参照）

【０００７】

【発明が解決しようとする課題】ところが、このような従来の製法では、以下のような課題があった。

【０００８】導体ペーストを製作してスクリーン印刷法により発熱パターンを敷設する方法では、発熱パターンを構成する抵抗発熱体の厚みばらつきを抑えるのに限界があり、この厚みばらつきによりセラミックヒータの発熱面における温度分布をさらに均一にすることが難しかった。

【０００９】即ち、導体ペーストを用いてスクリーン印刷法により発熱パターンを敷設するには、セラミック体を構成する１枚のセラミックグリーンシート上に、クリアランスを設けてスクリーンを設置し、このスクリーン上で抵抗発熱体用の導体ペーストをスキージにより引き延ばすことで導体ペーストが所定の発熱パターンに印刷されるのであるが、導体ペーストを引き延ばす際にはスキージに圧力をかけてスクリーン上を走査させることからスクリーンがたわみ、このたわみ量はスクリーンを支持する枠から離れた中央部ほど大きくなるために、発熱パターンの中央付近では印刷される導体ペーストの厚みが薄くなり、周縁では導体ペーストの厚みが厚くなるというようにばらつきがあり、この厚みばらつきを３μｍ以下に抑えることは困難であった。しかも、スキージへかける圧力が不均一であったり、導体ペーストの粘度が部分的に異なっていると、局所的に抵抗発熱体の厚みがばらつく恐れもあった。

【００１０】また、導体ペーストは粘度が小さいことから、グリーンシート積層体の形成時における押圧力によっても塑性変形し易く、抵抗発熱体の厚みばらつきを生じ易いといった課題もあった。

【００１１】そして、このような問題点は、セラミックヒータが大型化するにつれて顕著であり、特に、半導体装置の製造工程で用いられる加熱用ヒータにおいては、半導体ウエハの大型化に伴って直径が８インチ以上の大型セラミックヒータが要求されており、スクリーン印刷法により発熱パターンを形成したセラミックヒータでは発熱面の均熱化が困難になりつつあった。

【００１２】

【課題を解決するための手段】そこで、本発明は上記課題に鑑み、帯状の抵抗発熱体により構成される発熱パターン領域のほぼ中心点を通る少なくとも２本の線分により切断した切断面における各抵抗発熱体の厚みの最大値と最小値の差が、全切断面における抵抗発熱体厚みの平均値の１０％以内である発熱パターンを平板状のセラミック体中に埋設してセラミックヒータを構成したものである。

【００１３】特に、上記セラミック体を窒化アルミニウム質セラミックスにより形成すれば、セラミックヒータの発熱面における温度分布をより均一にすることができ好適である。

【００１４】また、本発明は、セラミック体を構成する複数枚のセラミックグリーンシートを製作する工程と、高融点金属やそれらの合金あるいは導電性セラミックスの粉末に溶媒とバインダーを添加混練してテープ成形法により抵抗発熱体用のグリーンシートを製作する工程と、該抵抗発熱体用のグリーンシートを上記セラミックグリーンシートの少なくとも１枚に積層したあと金型により所定の発熱パターンに打ち抜く工程と、該所定の発熱パターンに打ち抜いた抵抗発熱体用のグリーンシートを覆うように残りのセラミックグリーンシートを積層してグリーンシート積層体を形成する工程と、該グリーンシート積層体を脱脂し、しかるのち焼成する工程とからセラミックヒータを製造したものである。

【００１５】即ち、本発明のセラミックヒータによれば、セラミック体中の発熱パーンを構成する帯状の抵抗発熱体の厚みばらつきを、従来のスクリーン印刷法では得られないほど小さくしてあることから、セラミックヒータを発熱させれば、発熱面の温度分布を極めて均一にすることができる。

【００１６】また、このような発熱ムラの少ないセラミックヒータを得るために本発明では、テープ成形法によって導体ペーストより塑性変形し難い抵抗発熱体用のグリーンシートを製作し、金型により所定の発熱パターンに打ち抜いたものをセラミック体を構成するセラミックグリーンシート間に挟み込んでグリーンシート積層体を製作し、これを脱脂、焼成して製造するようにしたことから、大型のセラミックヒータにおいても発熱パターンを構成する帯状の抵抗発熱体には厚みばらつきが殆どない状態でセラミック体中に埋設することができる。

【００１７】

【発明の実施の形態】以下、本発明の実施形態について説明する。

【００１８】図１（ａ）は本発明のセラミックヒータを半導体装置の製造工程で使用される加熱用ヒータとして用いた例を示す斜視図であり、（ｂ）は（ａ）のＸ－Ｘ線断面図である。

【００１９】このセラミックヒータ１は、平面形状が円形をした平板状のセラミック体２中に帯状の抵抗発熱体４を埋設するとともに、上記セラミック体２の一方の主面を半導体ウエハＷの支持と加熱のための発熱面３としてあり、セラミック体２の他方の主面には抵抗発熱体４に通電するための給電端子５を接合してある。

【００２０】そして、発熱面３に半導体ウエハＷを載置し、抵抗発熱体４に交流電圧を印加してセラミックヒータ１を発熱させることにより、発熱面３上に支持する半導体ウエハＷを直接加熱するようになっている。

【００２１】なお、図１では平面形状が円形をしたセラミックヒータ１の例を示したが、これ以外に平面形状が楕円形、あるいは四角形や五角形など多角形をしたものなどどのような形状をしたものであっても構わない。

【００２２】このようなセラミック体２を構成する材質としては、アルミナセラミックス、窒化珪素質セラミックス、窒化アルミニウム質セラミックス、炭化硼素質セラミックス等を用いることができる。これらの中でも窒化アルミニウム質セラミックスは成膜装置やエッチング装置で使用されるハロゲン系腐食性ガス下において優れた耐プラズマ性を有するとともに、セラミックスの中でも非常に高い熱伝導率を有することからセラミック体２として好適に用いることができる。特に、純度が９９．８％以上である高純度窒化アルミニウム質セラミックスは、焼結体中に粒界が殆どなく、耐プラズマ性に優れることから腐食摩耗が激しい時には最適であり、また、Y_2O_3やＥｒなどの希土類酸化物を１～９重量％の範囲で含有する窒化アルミニウム質セラミックスでは、熱伝導率が１００Ｗ／ｍｋ以上、高いものでは１５０Ｗ／ｍｋ以上、さらに高いものでは２００Ｗ／ｍｋ以上を有することから発熱面４に載置した半導体ウエハＷの均熱化をより一層高めることができるとともに、処理温度に加熱するまでの時間や冷却時間を短くすることができる。

【００２３】また、これらのセラミック体２中に埋設する抵抗発熱体４の材質としては、タングステン（Ｗ）やモリブデン（Ｍｏ）など周期律表第６ａ族やＴｉなどの周期律表第４ａ族の高融点金属あるいはこれらの合金、さらにはＷＣ、ＭｏＣ、ＴｉＮなどの導電性セラミックスを用いることができる。これらの金属、合金、導電性セラミックスは上記セラミック体２を構成するセラミッ

クスと同程度の熱膨張係数を有することから、製作時や発熱時におけるセラミック体２の反りや破損を防ぐことができるとともに、高温度に発熱させても断線することがない。

【００２４】さらに、上記セラミック体２中の抵抗発熱体４へ通電するための給電端子５としては、タングステン（Ｗ）、モリブデン（Ｍｏ）、ニッケル（Ｎｉ）などの金属や鉄（Ｆｅ）－コバルト（Ｃｏ）－ニッケル（Ｎｉ）合金を用いることができ、特に耐酸化性が要求されるような時にはニッケル（Ｎｉ）あるいは鉄（Ｆｅ）－コバルト（Ｃｏ）－ニッケル（Ｎｉ）合金を用いることが良い。

【００２５】ところで、上記セラミック体２中に埋設する抵抗発熱体４の発熱パターンとしては、円形の発熱面３を均一に加熱するために、図２（ａ）に示すような同心円を構成するように配置された円弧状の抵抗発熱体４ａと、隣合う円弧状の抵抗発熱体４ａ同士を接続する直線状の抵抗発熱体４とからなり、中心部に延びる２本の円弧状の抵抗発熱体４ａの端部を電極取り出し部４ｃとしてある。このような発熱パターンＳとすれば、中心を通るどの部分で切断しても左右をほぼ同形状とすることができるため、発熱面３の温度分布を均一することができる。

【００２６】なお、発熱パターンＳの形状としては図２（ａ）に示したものだけに限定されるものではなく、セラミック体２の構造や発熱面３の形状に合わせて適宜設計すれば良い。ただし、図１のセラミックヒータ１のように発熱面３が円形をしたものである場合には図２（ａ）に示す発熱パターンＳや電極取り出し部４ｃが最外周にある図２（ｂ）に示すようなパターン形状を有するものが好ましい。

【００２７】そして、本発明のセラミックヒータ１によれば、上記発熱パターン領域のほぼ中心点を通る少なくとも２本の線分により切断した切断面における各抵抗発熱体４の厚みの最大値と最小値の差が、全切断面における抵抗発熱体４厚みの平均値の１０％以内であることを特徴とする。

【００２８】ここで、発熱パターン領域のほぼ中心点を通る少なくとも２本の線分により切断した切断面における各抵抗発熱体４の厚みの最大値と最小値の差が、全切断面における抵抗発熱体４厚みの平均値の１０％以内であるとは、例えば図３に示すように発熱パターン領域の中心を通る４本の線分により４５°間隔でセラミック体２を８等分に切断し、これらの切断面に現れる各抵抗発熱体４の厚みｔを測定してその最大値と最小値を求めるとともに、全切断面に現れる抵抗発熱体４の厚みｔの平均値を算出する。なお、厚みｔの測定に際しては各抵抗発熱体４において最も厚い部分を抵抗発熱体４の厚みｔとして算出する。そして、切断面における各抵抗発熱体４の厚みｔの最大値と最小値との差が、全切断面における抵抗発熱体４の厚みｔの平均値の１０％以内となっていることを言う。

【００２９】このように本発明では発熱パターンＳを構成する帯状の抵抗発熱体４の厚みばらつきが極めて小さいことから、発熱面４の温度分布を均一にすることができ、また、構造上の問題から熱引け等によって局所的に発熱ムラを生じるような場合でも発熱パターンＳを構成する帯状の抵抗発熱体４の厚みばらつきが極めて小さいことから、発熱ムラのある箇所における抵抗発熱体４の幅を変更するだけで抵抗値を容易に調整することができ、発熱面３の発熱ムラを簡単に制御することができる。

【００３０】ところで、このようなセラミックヒータ１を製作するには、まず、図４（ａ）に示すように、前記セラミック体２を構成する複数枚のセラミックグリーンシート２ａ，２ｂ，・・・を形成する。セラミックグリーンシート２ａ，２ｂ，・・・は、前記セラミック粉末に対して必要に応じて所定の助剤成分を添加するとともに、溶媒とバインダーを添加混練して泥漿を作製したあと、ドクターブレード法、引き上げ法、カレンダ法、紙鋳込み法、ペーパキャスティング法、ロールコンパクション法等のテープ成形法により成形すれば良い。

【００３１】一方、図４（ｂ）に示すように抵抗発熱体４は、前記金属、合金、導電性セラミックスの粉末に対して溶媒とバインダーを添加混練して泥漿を作製し、この泥漿をドクターブレード法、引き上げ法、カレンダ法、紙鋳込み法、ペーパキャスティング法、ロールコンパクション法等のテープ成形法を用いて厚み幅が均一な抵抗発熱体４用のグリーンシート４’を形成する。なお、上記テープ成形法にてグリーンシート４’を成形した際に厚みの均一化が図れない時や、厚み幅ｔが厚すぎる時は、所定の均一なギャップを有するロール間を通過させることにより、厚みをならし、均一化を図れば良い。

【００３２】そして、図４（ｃ）に示すように得られた抵抗発熱体４用のグリーンシート４’を上記複数枚のセラミックグリーンシート２ａ，２ｂ，・・・のうち例えば１枚のセラミックグリーンシート２ｈ上に積層する。なお、発熱パターンＳを２層以上埋設する場合には、他のセラミックグリーンシートに抵抗発熱体４用のグリーンシート４’を積層すれば良い。

【００３３】次に、図４（ｄ）に示すように、図２（ａ）の発熱パターンＳと同形状の凸部を有する金型でセラミックグリーンシート２ｈ上に積層した抵抗発熱体４用のグリーンシート４’を打ち抜いたあと、図４（ｅ）に示すように上記発熱パターンＳを覆うように残りのセラミックグリーンシート２ａ，２ｂ，・・・を積層してグリーンシート積層体８を製作する。

【００３４】しかるのち、グリーンシート積層体８に切削加工を施して平面形状を円形としたあと、このグリー

ンシート積層体８を脱脂し、次いで各種セラミック原料を焼結させることができる温度にて焼成することにより図４（ｆ）に示すように発熱パターンＳを埋設してなるセラミック体２を形成する。

【００３５】そして、上記セラミック体２の一方の主面に研磨加工を施してその面粗さを中心線平均粗さ（Ｒａ）で１μｍ以下とし、発熱面３を形成するとともに、セラミック体２の他方の主面に抵抗発熱体４の電極取り出し部４ｃと連通する穴を穿設し、この穴に給電端子５をロウ材でもって接合し、抵抗発熱体４と給電端子５とをそれぞれ電気的に接続することにより図１のセラミックヒータ１を得ることができる。

【００３６】かくして、本発明のセラミックヒータ１によれば、発熱パターンＳを構成する抵抗発熱体４の厚みばらつきが非常に小さいことから、セラミックヒータ１を発熱させれば、発熱面３の発熱ムラを生じることなく、均一に発熱させることができ、このセラミックヒータ１を半導体装置の製造工程における成膜装置やエッチング装置に使用される加熱用ヒータとして用いれば、発熱面３に支持する半導体ウエハを均一に発熱させることができるため、均一な厚み幅を持った薄膜を形成したり、所定の精度に微細加工を施すことができるとともに、ハロゲン系腐食性ガス下でプラズマに曝されたとしても抵抗発熱体４は耐プラズマ性に優れたセラミックスにより覆ってあるため、長期間にわたり使用することができる。

【００３７】なお、本実施形態では、半導体装置の製造工程における成膜装置やエッチング装置に使用される加熱用ヒータの例をもって説明したが、本発明のセラミックヒータは他に、燃焼機器の点火用ヒータや加熱機器、測定機器等の加熱用ヒータなどさまざまな分野で使用されるヒータとしても好適に用いることができることは言うまでもない。

【００３８】（実施例１）図１に示すような本発明のセラミックヒータ１と従来のセラミックヒータとを用意し、抵抗発熱体４の厚みばらつきと発熱面３の温度分布を比較する実験を行った。

【００３９】本実験ではセラミック体２を純度９９．９％の窒化アルミニウム質セラミックスにより形成するとともに、抵抗発熱体４にタングステンを用いた。また、発熱パターンＳを構成する抵抗発熱体４の目標寸法を厚みｔ１５μｍ、幅５ｍｍとした。

【００４０】具体的には、純度９９．９％のＡｌＮ粉末に対して溶媒とバインダーを添加混練して泥漿を作製し、ドクターブレード法にて複数枚のセラミックグリーンシートを複数枚形成した。

【００４１】そして、従来品ではタングステンの粉末に対してテルピネオールの溶媒とアクリル系のバインダーを添加混練して抵抗発熱体４用の導体ペーストを製作し、この導体ペーストを図２に示す発熱パターンＳのようにスクリーン印刷法にて前記セラミックグリーンシートの１枚に積層してグリーンシート積層体を形成し、本発品はタングステンの粉末に対して溶媒にトルエンをバインダーにポリアクリル酸エチルをそれぞれ添加混練して泥漿を作製し、ドクターブレード法にて抵抗発熱体４用のグリーンシートを形成したものをセラミックグリーンシートの１枚に積層したあと、図２に示す発熱パターンＳとなるように金型にて打ち抜いたものを残りのセラミックグリーンシートで覆ってグリーンシート積層体を形成した。

【００４２】そして、これらのグリーンシート積層体を窒素雰囲気中にて脱脂し、次いで２０１０℃程度の温度で焼成することにより発熱パターンＳを埋設したセラミック体２を形成し、このセラミック体２の一方の主面に研磨加工を施して発熱面３を形成するとともに、他方の主面にドリルにて抵抗発熱体３に連通する２つの穴を穿設し、これらの穴に鉄－コバルト－ニッケル合金からなる給電端子５をロウ付け固定することにより各セラミックヒータ１を製作した。

【００４３】そして、得られた各セラミックヒータ１に周波数６０Ｈｚ、１００Ｖの交流電圧を印加して５００℃の設定温度に発熱させ、発熱面３の表面温度をサーモビュアーにより測定した。温度測定ポイントは図５に示すａ～ｓの点とした。なお、温度測定ポイントはＸ線により発熱パターン領域を確認して行った。

【００４４】次に、温度を測定をしたあと発熱パターン領域の中心を通る４本の線分（測定ポイントを通る）により各セラミックヒータを切断し、その切断面に現れる各抵抗発熱体４の厚みｔを測定することにより抵抗発熱体４の厚みばらつきを測定した。

【００４５】それぞれの結果は表１に示す通りである。

【００４６】

【表１】

9

測定ポイント	本発明		従来例	
	抵抗発熱体の厚み(μm)	温度(℃)	抵抗発熱体の厚み(μm)	温度(℃)
a	14.3	500	16.2	500
b	14.5	499	15.8	498
c	14.8	498	16.3	501
d	14.9	499	17.3	488
e	14.5	500	16.9	481
f	14.2	501	18.2	485
g	14.5	499	16.9	483
h	14.3	502	14.5	512
i	14.5	500	16.1	507
j	14.3	501	15.0	505
k	15.0	500	14.9	500
l	15.1	504	15.5	499
m	14.8	503	14.7	501
n	14.7	502	13.0	518
o	14.4	505	13.5	515
p	15.0	503	13.2	510
q	14.6	504	13.9	511
r	14.5	505	13.3	508
s	14.6	504	13.7	512
①平均値	14.6	502	15.4	502
②最大値－最小値	0.9	7	5.2	37
②／①（%）	6	1	34	7

【００４７】この結果、従来品では切断面に現れる各抵抗発熱体４の厚みｔの最大値と最小値の差が、全抵抗発熱体４の厚みｔの平均値に対して３４％と抵抗発熱体４の厚みｔにかなりばらつきがあることが判る。その為、発熱面３における最大値と最小値との差が３７℃と発熱ムラが大きかった。

【００４８】これに対し、本発明品は切断面に現れる各抵抗発熱体４の厚みｔの最大値と最小値の差が、全抵抗発熱体３の厚みｔの平均値に対して１％と抵抗発熱体４の厚みばらつきを大幅に低減できることが判る。その為、発熱面３における最大値と最小値との差は７℃と比較品の２０％以下にまで発熱ムラを抑え、発熱面３の温度分布を大幅に高めることができた。

【００４９】（実施例２）そこで、本発明のセラミックヒータ１において、抵抗発熱体４の厚みばらつきを故意に変更させ、実施例１と同様の条件にて抵抗発熱体４の厚みばらつきと発熱面３の温度分布との関係について調べる実験を行った。

【００５０】そして、近年、発熱面３の温度ばらつきとしては最大温度と最小温度との差を２０℃以下とすることが望まれていることから、２０℃以下の場合を発熱良好として評価した。

【００５１】それぞれの結果は表２に示す通りである。

【００５２】

【表２】

10

	抵抗発熱体のばらつき ②／①（%）	発熱面の温度ばらつき
1	6	7
2	9	13
3	12	21
4	17	26
5	22	28

①：全抵抗発熱体の厚み　の平均値
②：各抵抗発熱体の厚み　の最大値と最小値の差
※は本発明範囲外である。

＊【００５３】この結果、切断面に現れる各抵抗発熱体４の厚みｔの最大値と最小値の差が、全抵抗発熱体３の厚みｔの平均値に対して１０％以下とすれば、発熱面３の温度ばらつきを２０℃以下とできることが判る。

【００５４】

【発明の効果】以上のように、本発明によれば、高融点金属やそれらの合金あるいは導電性セラミックスの粉末に溶媒とバインダーを添加混練してテープ成形法により抵抗発熱体用のグリーンシートを製作し、金型により所定の発熱パターンに打ち抜いたものをセラミック体を構成するセラミックグリーンシート間に挟み込んでグリーンシート積層体を形成したあと脱脂し、次いで焼成することにより、帯状の抵抗発熱体により構成される発熱パターン領域のほぼ中心点を通る少なくとも２本の線分により切断した切断面における各抵抗発熱体４の厚みｔの最大値と最小値の差が、全切断面における抵抗発熱体４厚みの平均値の１０％以内である発熱パターンを平板状のセラミック体２中に埋設してセラミックヒータを構成したことから、発熱パターンを構成する抵抗発熱体の厚みばらつきを極めて小さくすることができるため、発熱面の温度分布を均一にすることができる。その為、例えば、本発明のセラミックヒータを成膜装置やエッチング装置などで使用される加熱用ヒータとして用いれば、被加熱物に対して均一な成膜や微細加工を施すことができるとともに、抵抗発熱体が耐食性に優れたセラミックスにより覆われていることから、フッ素系や塩素系などのハロゲン系腐食性ガス下でプラズマに曝されたとしても大きく摩耗することがなく長期間にわたって用いることができる。

【図面の簡単な説明】

【図１】（ａ）は本発明のセラミックヒータを半導体装置の製造工程で使用される加熱用ヒータとして用いた例を示す斜視図であり、（ｂ）は（ａ）のＸ－Ｘ線断面図である。

【図２】（ａ）は図１のセラミックヒータ内に埋設してある抵抗発熱体の発熱パターンを示す模式図であり、（ｂ）は他の発熱パターンを示す模式図である。

11

【図３】図１のセラミックヒータを切断した状態を示す斜視図である。

【図４】（ａ）～（ｆ）は図１のセラミックヒータの製造工程を示す図である。

【図５】発熱面における温度測定ポイントを示す図である。

【符号の説明】

12

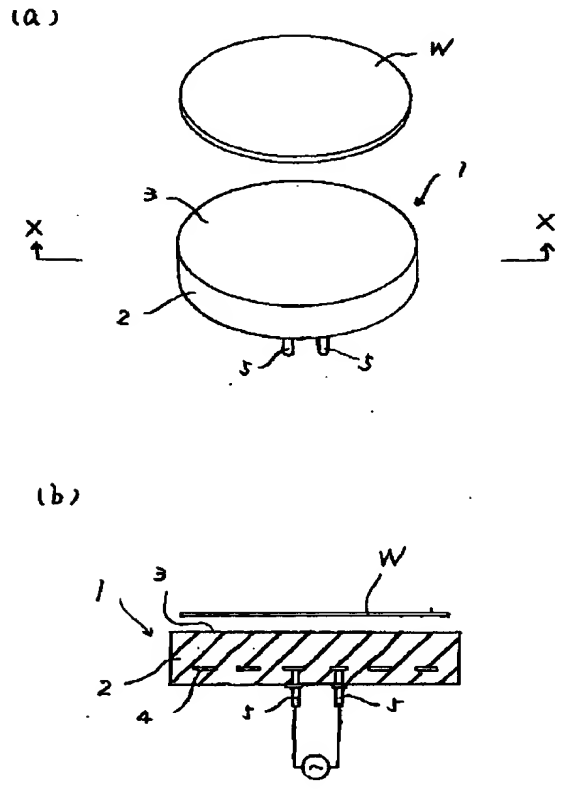
＊１・・・セラミックヒータ　２・・・セラミック体　３・・・発熱面

４・・・抵抗発熱体　４ａ・・・円弧状の抵抗発熱体

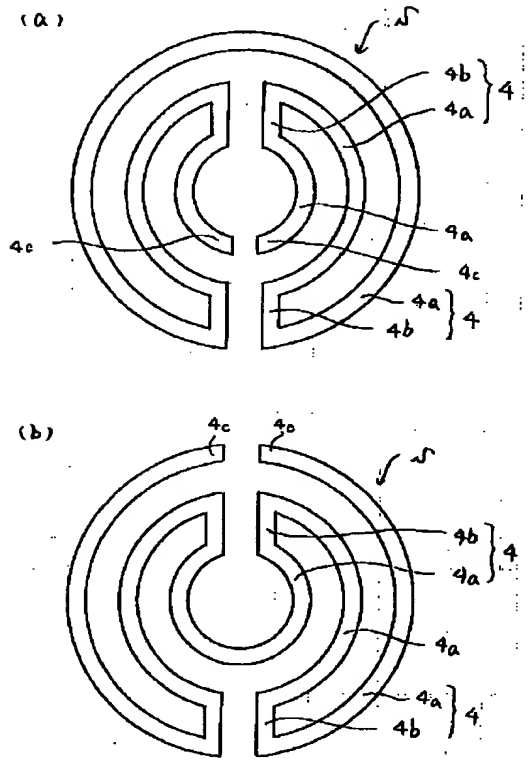
４ｂ・・・円弧状の抵抗発熱体　５・・・給電端子　Ｓ・・・発熱パターン

Ｗ・・・半導体ウエハ

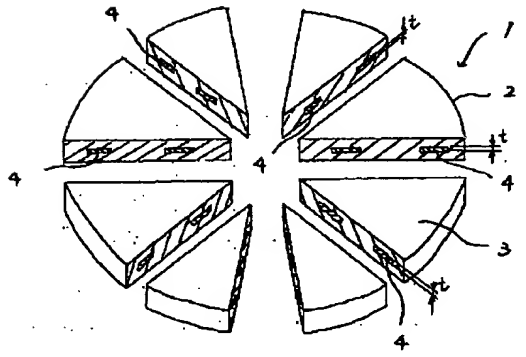
【図１】



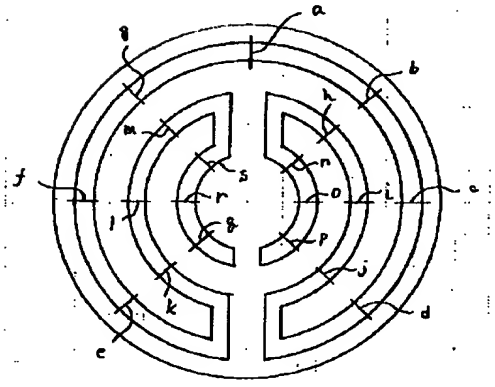
【図２】



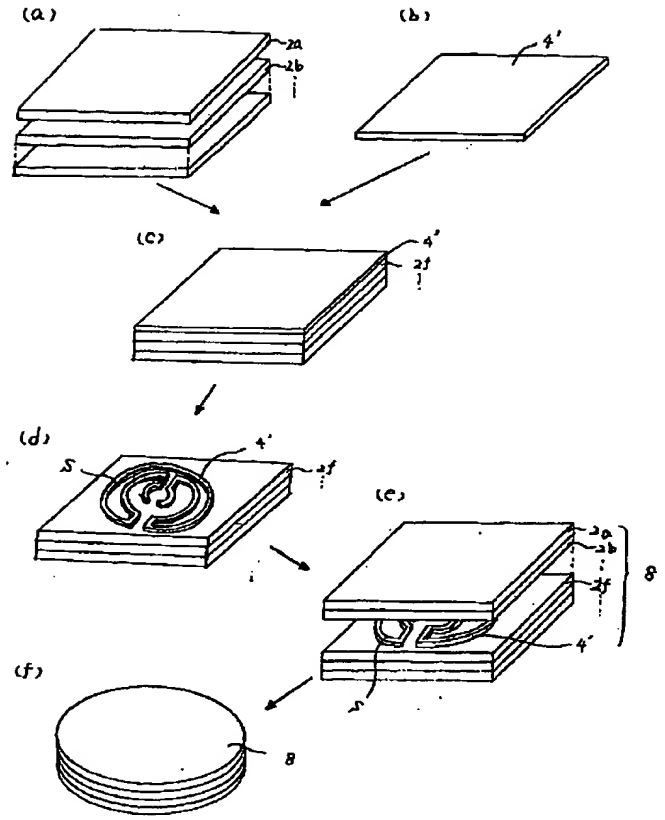
【図３】



【図５】



【図４】



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thickness dispersion.

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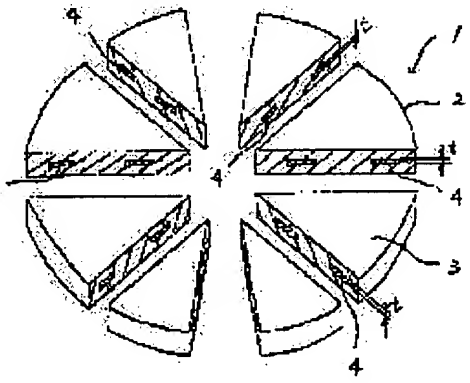
(71)Applicant : KYOCERA CORP

(72)Inventor : FUKUI KIYOSHI

(54) CERAMIC HEATER AND ITS MANUFACTURE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a ceramic heater in which temperature is uniformly distributed on a heating surface by minimizing a thickness dispersion of a resistance heating element embedded in a ceramic body.



SOLUTION: A green sheet for a resistance heating element is produced by a tape forming method by adding solvent and binder to metal with a high fusing point, its alloy or conductive ceramics powder and kneading them, and after forming a green sheet laminated body by inserting a piece blanked out to a designated heating pattern by a die between the green sheets to compose a ceramic body, it is degreased, and is then baked. A heating pattern in which a difference between the maximum value and the minimum value of a thickness (t) of each heating element 4 in a cutting plane cut by at least two line segments passing through an almost center point in a heating pattern region composed by a band shaped resistance heater element 4 is not more than 10% of an average thickness value of the resistance heating element 4 in all cutting planes, is embedded in a flat ceramic body 2 in order to compose a ceramic heater 1.

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[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

* NOTICES *

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2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] the exoergic pattern whose difference of the maximum of the thickness of each resistance heating element which appears in the cutting plane cut by at least two segments of the exoergic pattern space constituted with a band-like resistance heating element which pass along the central point mostly, and the minimum value is less than 10% which appears in all cutting planes of the average of resistance heating element thickness -- a plate-like ceramic -- the ceramic heater which it comes to lay under the inside of the body
[Claim 2] The ceramic heater according to claim 1 whose above-mentioned ceramic objects are the nature ceramics of alumimium nitride.
[Claim 3] The manufacture method of a ceramic heater characterized by providing the following. The process which manufactures the ceramic green sheet of two or more sheets which constitutes a ceramic object. The process which carries out addition kneading of a solvent and the binder at the powder of refractory metals, those alloys, or conductive ceramics, and manufactures the green sheet for resistance heating elements by the tape-forming method. The process which carries out the laminating of the green sheet for these resistance heating elements to at least one sheet of the above-mentioned ceramic green sheet, and is pierced to a predetermined exoergic pattern with metal mold. The process which carries out the laminating of the remaining ceramic green sheet, and forms a green-sheet layered product so that the green sheet for resistance heating elements pierced to this predetermined exoergic pattern may be covered, and the process which degreases this green-sheet layered product and is calcinated the appropriate back.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] (a) is the perspective diagram showing the example which used the ceramic heater of this invention as a heater for heating used by the manufacturing process of a semiconductor device, and (b) is the X-X line cross section of (a).
[Drawing 2] (a) is the ** type view showing the exoergic pattern of the resistance heating element currently laid underground in the ceramic heater of drawing 1 , and (b) is the ** type view showing other exoergic patterns.
[Drawing 3] It is the perspective diagram showing the state where the ceramic heater of drawing 1 was cut.
[Drawing 4] (a) - (f) is drawing showing the manufacturing process of the ceramic heater of drawing 1 .
[Drawing 5] It is drawing showing the thermometry point in an exoergic side.
[Description of Notations]
1 ... Ceramic heater 2 ... Ceramic object 3 ... Exoergic side
4 ... Resistance heating element 4a ... Circular resistance heating element
4b ... Circular resistance heating element 5 ... Electric supply terminal S ... Exoergic pattern
W ... Semiconductor wafer

[Translation done.]

* NOTICES *

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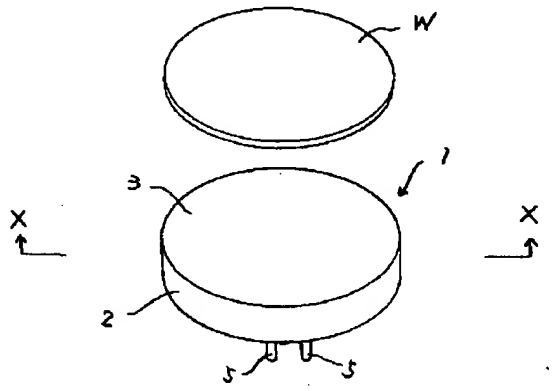
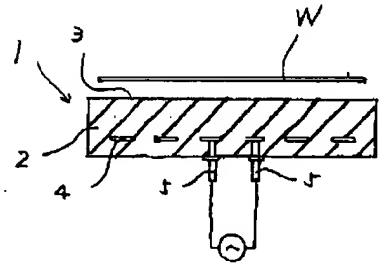
DRAWINGS

[Drawing 1]

(a)

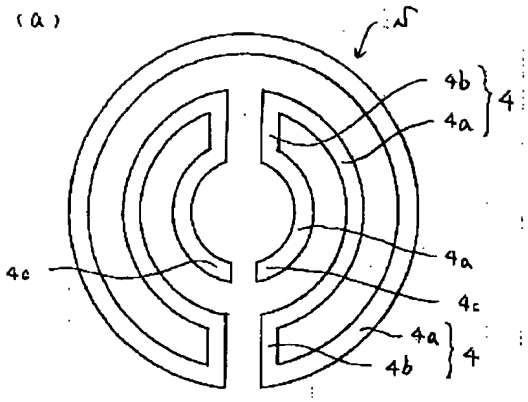


(b)

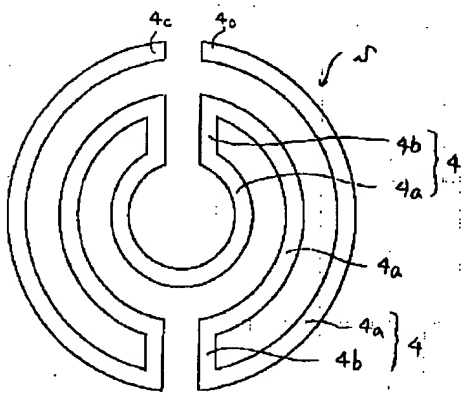


[Drawing 2]

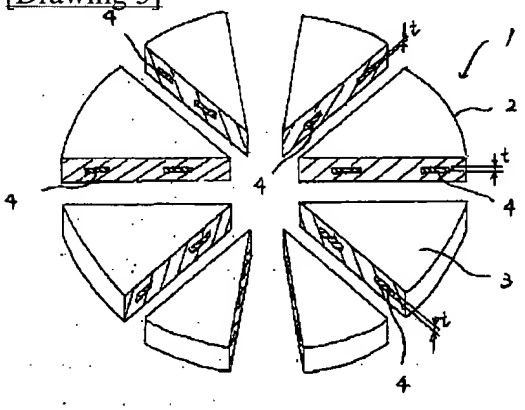
(a)



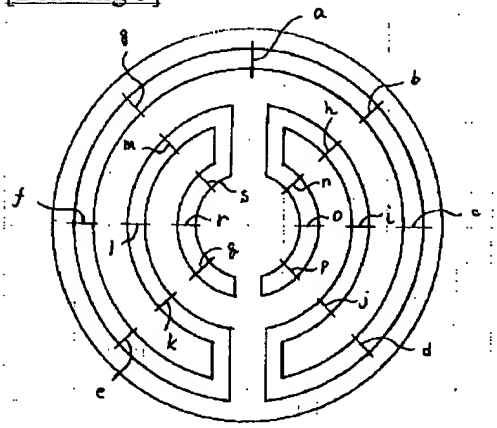
(b)



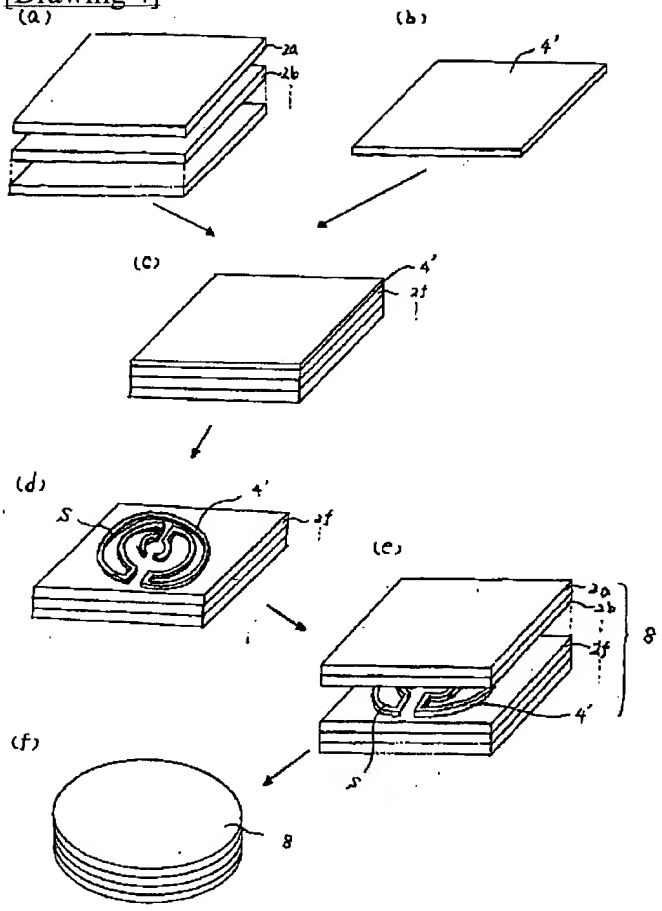
[Drawing 3]



[Drawing 5]



[Drawing 4]



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] It is a thing about the ceramic heater which has the exoergic pattern constituted by the inside of the body with a band-like resistance heating element. this invention -- a ceramic -- For example, it is what is used as the heater for ignition of various burning appliances, and a heater for heating of various heating devices or measuring equipment. It is suitable as a heater for heating for heating the semiconductor wafer especially used for etching systems, such as membrane formation equipments, such as plasma CVD in the manufacturing process of a semiconductor device, reduced pressure CVD, and Light CVD and PVD, and plasma etching, optical etching.
[0002]
[Description of the Prior Art] as the former and a ceramic heater -- ceramics, such as alumina ceramics and nature ceramics of a silicon nitride, -- that which laid under the inside of the body the resistance heating element which consists of conductive ceramics, such as refractory metals, such as a tungsten (W) and molybdenum (Mo), and TiN, is known, and, generally these ceramic heaters are widely used from excelling in thermal resistance, electric insulation, corrosion resistance, and abrasion resistance
[0003] Moreover, the ceramic heater using the nature ceramics of alumimium nitride as for [special] uses is also proposed in recent years.
[0004] For example, the semiconductor wafer which is a heated object in etching systems, such as membrane formation equipments used by the manufacturing process of a semiconductor device, such as plasma CVD, reduced pressure CVD, and Light CVD and PVD, and plasma etching, optical etching, (a wafer is called hereafter.)
[0005] While having the plasma-proof nature excellent in the bottom of the fluorine system for which the above-mentioned ceramic heater is used as a heater for heating for heating to various processing temperature, and the inside of it is also used by membrane formation equipment or the etching system, or the halogen system corrosive gas of ********, supporting, the thing using the nature ceramics of alumimium nitride equipped with the high temperature conduction property attracts attention.
[0006] As a method of manufacturing such a ceramic heater First, while preparing the ceramic green sheet of two or more sheets which constitutes a ceramic object A paste is manufactured. a ceramic -- as the resistance heating element laid under the inside of the body -- the powder of a refractory metal or conductive ceramics -- a solvent and a binder -- respectively -- addition kneading -- carrying out -- the conductor for resistance heating elements -- It lays to one sheet of the aforementioned ceramic green sheet by technique, such as screen printing. this conductor -- a paste so that it may become a predetermined exoergic pattern this conductor -- a paste -- a wrap, after carrying out the laminating of the remaining ceramic green sheet like and forming a green-sheet layered product Degrease and the ceramic object which comes to lay underground the exoergic pattern which consists of a band-like resistance heating element by next calcinating at predetermined temperature is manufactured. There were some which manufactured the ceramic heater by exposing some above-mentioned exoergic patterns the appropriate back, using low material there, and joining an electric supply terminal (refer to

JP,8-34123,B).
[0007]
[Problem(s) to be Solved by the Invention] However, the following technical problems occurred in such a conventional process.
[0008] a conductor -- it was difficult for a limitation to be to suppress thickness dispersion of the resistance heating element which constitutes an exoergic pattern from a method of manufacturing a paste and laying an exoergic pattern with screen printing, and to make further the temperature distribution in the exoergic side of a ceramic heater into homogeneity by this thickness dispersion
[0009] namely, a conductor, in order to lay an exoergic pattern with screen printing using a paste the ceramic green-sheet top of one sheet which constitutes a ceramic object -- path clearance -- preparing -- a screen -- installing -- the conductor for resistance heating elements in this screen top -- extending a paste by the squeegee -- a conductor, although a paste is printed by the predetermined exoergic pattern a conductor -- a screen bending, since a pressure is put on a squeegee and a screen top is made to scan, in case a paste is extended, and this amount of deflections, since the center section more distant from the frame which supports a screen becomes large the conductor printed near the center of an exoergic pattern -- the thickness of a paste -- thin -- becoming -- a periphery -- a conductor -- it was difficult for there to be dispersion as the thickness of a paste becomes thick, and to suppress this thickness dispersion to 3 micrometers or less and -- that the pressure put on a squeegee is uneven **** -- a conductor -- when the viscosity of a paste differed partially, there was also a possibility that the thickness of a resistance heating element might vary locally
[0010] moreover, a conductor -- since viscosity was small, it was easy to deform a paste also according to the press force at the time of formation of a green-sheet layered product plastically, and it also had the technical problem that it was easy to produce thickness dispersion of a resistance heating element
[0011] And it is remarkable as a ceramic heater enlarges such a trouble, and in the heater for heating especially used by the manufacturing process of a semiconductor device, soaking-ization of an exoergic side was becoming difficult with enlargement of a semiconductor wafer by the ceramic heater in which the large-sized ceramic heater 8 inches or more is demanded, and the diameter formed the exoergic pattern with screen printing.
[0012]
[Means for Solving the Problem] then, the exoergic pattern whose difference of the maximum of the thickness of each resistance heating element and the minimum value in the cutting plane which cut this invention in view of the above-mentioned technical problem by at least two segments of the exoergic pattern space constituted with a band-like resistance heating element which pass along the central point mostly is less than 10% of the average of the resistance heating element thickness in all cutting planes -- a plate-like ceramic -- it lays under the inside of the body, and a ceramic heater is constituted
[0013] If the above-mentioned ceramic object is especially formed with the nature ceramics of alumimium nitride, the temperature distribution in the exoergic side of a ceramic heater can be made more into homogeneity, and it is suitable.
[0014] Moreover, the process which manufactures the ceramic green sheet of two or more sheets from which this invention constitutes a ceramic object, The process which carries out addition kneading of a solvent and the binder at the powder of refractory metals, those alloys, or conductive ceramics, and manufactures the green sheet for resistance heating elements by the tape-forming method, The process pierced to a predetermined exoergic pattern with metal mold after carrying out the laminating of the green sheet for these resistance heating elements to at least one sheet of the above-mentioned ceramic green sheet, The process which carries out the laminating of the remaining ceramic green sheet, and forms a green-sheet layered product so that the green sheet for resistance heating elements pierced to this predetermined exoergic pattern may be covered, This green-sheet layered product is degreased and a ceramic heater is manufactured from the process calcinated the appropriate back.
[0015] namely, -- according to the ceramic heater of this invention -- a ceramic -- since it is made so small that thickness dispersion of the band-like resistance heating element which constitutes exoergic Pan in the living body cannot be acquired with the conventional screen printing, if a ceramic heater is

made to generate heat, the temperature distribution of an exoergic side can be made very uniform
[0016] In order to obtain a ceramic heater with little such exoergic nonuniformity moreover, in this invention The green sheet for resistance heating elements which is hard to deform from a paste plastically is manufactured. a tape-forming method -- a conductor -- Put what was pierced to the predetermined exoergic pattern with metal mold between the ceramic green sheets which constitute a ceramic object, and a green-sheet layered product is manufactured. the state where there is almost no thickness dispersion in the band-like resistance heating element which constitutes an exoergic pattern from degreasing and calcinating this and having manufactured it also in a large-sized ceramic heater -- a ceramic -- it can lay under the inside of the body
[0017]
[Embodiments of the Invention] Hereafter, the operation gestalt of this invention is explained.
[0018] Drawing 1 (a) is the perspective diagram showing the example which used the ceramic heater of this invention as a heater for heating used by the manufacturing process of a semiconductor device, and (b) is the X-X line cross section of (a).
[0019] This ceramic heater 1 is made into the exoergic side 3 for support of the semiconductor wafer W and heating of one principal plane of the above-mentioned ceramic object 2, and has joined the electric supply terminal 5 for energizing to the resistance heating element 4 to the principal plane of another side of the ceramic object 2 while it lays the band-like resistance heating element 4 underground into the plate-like ceramic object 2 with which the flat-surface configuration carried out the round shape.
[0020] And the semiconductor wafer W supported on the exoergic side 3 is directly heated by laying the semiconductor wafer W in the exoergic side 3, impressing alternating voltage to the resistance heating element 4, and making a ceramic heater 1 generate heat.
[0021] In addition, although drawing 1 showed the example of the ceramic heater 1 to which the flat-surface configuration carried out the round shape, a flat-surface configuration may carry out what configurations, such as what carried out polygons, such as an ellipse form or a square, and a pentagon, addition to this.
[0022] As the quality of the material which constitutes such a ceramic object 2, alumina ceramics, the nature ceramics of a silicon nitride, the nature ceramics of alumimium nitride, the nature ceramics of a boron carbide, etc. can be used. Since the inside of these or the nature ceramics of alumimium nitride has thermal conductivity very high also in ceramics while having the plasma-proof nature which was excellent under the halogen system corrosive gas used by membrane formation equipment or the etching system, they can be suitably used as a ceramic object 2. Especially the nature ceramics of high grade alumimium nitride whose purity is 99.8% or more Since there is almost no grain boundary into a sintered compact and it excels in plasma-proof nature, when a corrosive wear is intense, are the optimal. Moreover, Y2 O3 With the nature ceramics of alumimium nitride contained in 1 - 9% of the weight of the range, rare earth oxides, such as Er Since thermal conductivity has 150 or more W/mk in 100 or more W/mk and a high thing and has 200 or more W/mk in a still higher thing, while being able to raise further soaking-ization of the semiconductor wafer W laid in the exoergic side 4 Time and a cooldown delay until it heats to processing temperature can be shortened.
[0023] moreover -- as the quality of the material of the resistance heating element 4 laid underground into these ceramic objects 2 -- the [, such as a tungsten (W) and molybdenum (Mo), / periodic-table] -- the [, such as 6a group and Ti, / periodic-table] -- 4a group's refractory metals, or these alloys -- conductive ceramics, such as WC, MoC, and TiN, can be used further Even if it makes high temperature generate heat, they are not disconnected, while they can prevent the curvature of the ceramic object 2 and breakage at the time of manufacture and generation of heat, since these metals, an alloy, and conductive ceramics have a coefficient of thermal expansion of the same grade as the ceramics which constitute the above-mentioned ceramic object 2.
[0024] furthermore, as an electric supply terminal 5 for energizing to the resistance heating element 4 in the above-mentioned ceramic object 2 Metals, such as a tungsten (W), molybdenum (Mo), and nickel (nickel), and an iron (Fe)-cobalt (Co)-nickel (nickel) alloy can be used. When especially oxidation resistance is required, it is good to use nickel (nickel) or an iron (Fe)-cobalt (Co)-nickel (nickel) alloy.

[0025] by the way, as an exoergic pattern of the resistance heating element 4 laid underground into the above-mentioned ceramic object 2 Circular resistance heating element 4a arranged so that a concentric circle as shown in drawing 2 (a) may be constituted, in order to heat the circular exoergic side 3 uniformly, It consists of a straight-line-like resistance heating element 4 which connects ****** radii-like resistance heating element 4a, and two edges of circular resistance heating element 4a prolonged in a core are set to electrode takeoff-connection 4c. Since right and left can be mostly made into the shape of isomorphism even if it cuts in such an exoergic pattern S, then which portion passing through a center, the homogeneity of the temperature distribution of the exoergic side 3 can be carried out.
[0026] In addition, what is necessary is not to be limited only to what was shown in drawing 2 (a) as a configuration of the exoergic pattern S, and just to design suitably according to the structure of the ceramic object 2, or the configuration of the exoergic side 3. However, when the exoergic side 3 carries out a round shape like the ceramic heater 1 of drawing 1 , what has a pattern configuration as shown in drawing 2 (b) which has the exoergic pattern S shown in drawing 2 (a) and electrode takeoff-connection 4c in the outermost periphery is desirable.
[0027] And according to the ceramic heater 1 of this invention, it is characterized by the difference of the maximum of the thickness of each resistance heating element 4 and the minimum value in the cutting plane cut by at least two segments of the above-mentioned exoergic pattern space which pass along the central point mostly being less than 10% of the average of the resistance heating element 4 thickness in all cutting planes.
[0028] The difference of the maximum of the thickness of each resistance heating element 4 and the minimum value in the cutting plane cut by at least two segments of an exoergic pattern space which pass along the central point mostly here that it is less than 10% of the average of the resistance heating element 4 thickness in all cutting planes For example, while four segments passing through the center of an exoergic pattern space cut the ceramic object 2 to eight division into equal parts at intervals of 45 degrees as shown in drawing 3 , and measuring thickness t of each resistance heating element 4 which appears in these cutting planes and calculating the maximum and minimum value The average of thickness t of the resistance heating element 4 which appears in all cutting planes is computed. In addition, on the occasion of measurement of thickness t, the thickest portion is computed as thickness [of the resistance heating element 4] t in each resistance heating element 4. And it says that the difference of the maximum of thickness t of each resistance heating element 4 and the minimum value in a cutting plane has become less than 10% of the average of thickness t of the resistance heating element 4 in all cutting planes.
[0029] thus, from a very small thing, thickness dispersion of the band-like resistance heating element 4 which constitutes the exoergic pattern S from this invention Thickness dispersion of the band-like resistance heating element 4 which constitutes the exoergic pattern S even when the temperature distribution of the exoergic side 4 can be made uniform and it produces exoergic nonuniformity from the problem on structure locally by ****** etc. from a very small thing Resistance can be easily adjusted only by changing the width of face of the resistance heating element 4 in a part with exoergic nonuniformity, and the exoergic nonuniformity of the exoergic side 3 can be controlled easily.
[0030] By the way, first, in order to manufacture such a ceramic heater 1, as shown in drawing 4 (a), the ceramic green sheets 2a and 2b of two or more sheets and ... which constitute the aforementioned ceramic object 2 are formed. What is necessary is just to fabricate by tape-forming methods, such as a doctor blade method, the Czochralski method, a calender, the paper casting method, the paper casting method, and the roll compaction method, after carrying out addition kneading of a solvent and the and producing a slurry, while the ceramic green sheets 2a and 2b and ... add a predetermined assistant component if needed to the aforementioned ceramic powder.
[0031] On the other hand, as shown in drawing 4 (b), the resistance heating element 4 carries out addition kneading of a solvent and the binder to the powder of the aforementioned metal, an alloy, and conductive ceramics, produces a slurry, and forms green-sheet 4' for resistance heating element 4 with uniform thickness width of face for this slurry using tape-forming methods, such as a doctor blade method, the Czochralski method, a calender, the paper casting method, the paper casting method, and

the roll compaction method. In addition, what is necessary is to accustom thickness and just to attain equalization by passing between the rolls which have a uniform predetermined gap, when green-sheet 4' is fabricated by the describing [above] tape-forming method and equalization of thickness cannot be attained, or when the thickness width of face t is too thick.

[0032] And the laminating of green-sheet 4' for resistance heating element 4 obtained as shown in drawing 4 (c) is carried out on [of one sheet] ceramic green-sheet 2h among the ceramic green sheets 2a and 2b of two or more above-mentioned sheets, and ... In addition, what is necessary is just to carry out the laminating of green-sheet 4' for resistance heating element 4 to other ceramic green sheets, in laying the exoergic pattern S underground more than two-layer.

[0033] Next, as shown in drawing 4 (d), after piercing green-sheet 4' for resistance heating element 4 which carried out the laminating on ceramic green-sheet 2h with the exoergic pattern S of drawing 2 (a), and the metal mold which has isomorphism-like heights, the laminating of the remaining ceramic green sheets 2a and 2b and ... is carried out, and the green-sheet layered product 8 is manufactured so that the above-mentioned exoergic pattern S may be covered, as shown in drawing 4 (e).

[0034] After performing cutting to the green-sheet layered product 8 and making a flat-surface configuration circular the appropriate back, this green-sheet layered product 8 is degreased, and the ceramic object 2 which lays the exoergic pattern S underground and becomes as shown in drawing 4 (f) is formed by calcinating at the temperature which can subsequently make various ceramic raw materials sinter.

[0035] And while giving polish processing to one principal plane of the above-mentioned ceramic object 2, setting the field granularity to 1 micrometer or less by (Ra) in center line average coarseness and forming the exoergic side 3 Electrode takeoff-connection 4c of the resistance heating element 4 and a hole open for free passage can be drilled in the principal plane of another side of the ceramic object 2, and it can have the electric supply terminal 5 in this hole by low material, and can join to it, and the ceramic heater 1 of drawing 1 can be obtained by connecting electrically the resistance heating element 4 and the electric supply terminal 5, respectively.

[0036] In this way, since thickness dispersion of the resistance heating element 4 which constitutes the exoergic pattern S is very small according to the ceramic heater 1 of this invention, if a ceramic heater 1 is made to generate heat If it can be made to generate heat uniformly and this ceramic heater 1 is used as a heater for heating used for membrane formation equipment and the etching system in a manufacturing process of a semiconductor device, without producing the exoergic nonuniformity of the exoergic side 3 Since the semiconductor wafer supported to the exoergic side 3 can be made to generate heat uniformly, while being able to form a thin film with uniform thickness width of face or being able to perform micro processing to a predetermined precision Since it has covered with the ceramics the resistance heating element 4 excelled [ceramics] in plasma-proof nature though plasma **(ed) under the halogen system corrosive gas, it can be used over a long period of time.

[0037] In addition, although this operation form explained with the example of the heater for heating used for membrane formation equipment and the etching system in a manufacturing process of a semiconductor device, the ceramic heater of this invention cannot be overemphasized by that it can use for others suitably also as a heater used in various fields, such as heaters for heating, such as a heater for ignition of a burning appliance, and a heating device, measuring equipment.

[0038] (Example 1) The ceramic heater 1 of this invention as shown in drawing 1 , and the conventional ceramic heater were prepared, and the experiment which compares thickness dispersion of the resistance heating element 4 with the temperature distribution of the exoergic side 3 was conducted.

[0039] In this experiment, while forming the ceramic object 2 with the nature ceramics of alumimium nitride of 99.9% of purity, the tungsten was used for the resistance heating element 4. Moreover, the target size of the resistance heating element 4 which constitutes the exoergic pattern S was made into thickness t15micrometer and width of face of 5mm.

[0040] Specifically, addition kneading of a solvent and the binder was carried out to the AlN powder of 99.9% of purity, the slurry was produced, and two or more ceramic green sheets of two or more sheets were formed in the doctor blade method.

[0041] A paste is manufactured. and the former -- elegance -- the powder of a tungsten -- receiving -- the solvent of a terpineol, and an acrylic binder -- addition kneading -- carrying out -- the conductor for resistance heating element 4 -- Carry out a laminating to one sheet of the aforementioned ceramic green sheet with screen printing like the exoergic pattern S which shows a paste to drawing 2 , and a green-sheet layered product is formed. this conductor -- To the powder of a tungsten, carry out toluene at a solvent, it carries out addition kneading of the polyacrylic-acid ethyl at a binder, respectively, and ****** produces a slurry. After carrying out the laminating of what formed the green sheet for resistance heating element 4 in the doctor blade method to one sheet of a ceramic green sheet, What was pierced with metal mold so that it might become the exoergic pattern S shown in drawing 2 was covered by the remaining ceramic green sheet, and the green-sheet layered product was formed.
[0042] And these green-sheet layered products are degreased in nitrogen atmosphere. Subsequently, while forming the ceramic object 2 which laid the exoergic pattern S underground by calcinating at the temperature of about 2010 degrees C, giving polish processing to one principal plane of this ceramic object 2 and forming the exoergic side 3 Two holes which are open for free passage to the resistance heating element 3 with a drill were drilled in the principal plane of another side, and each ceramic heater 1 was manufactured by carrying out low attachment fixation of the electric supply terminal 5 which becomes these holes from an iron-cobalt-nickel alloy.
[0043] And impressed the frequency of 60Hz, and the alternating voltage of 100V to each obtained ceramic heater 1, the setting temperature of 500 degrees C was made to generate heat, and the skin temperature of the exoergic side 3 was measured by the thermostat viewer. The thermometry point was made into the point of a-s shown in drawing 5 . In addition, the thermometry point checked the exoergic pattern space with the X-ray, and performed it.
[0044] Next, after measuring temperature, four segments (it passes along the measurement point) passing through the center of an exoergic pattern space cut each ceramic heater, and thickness dispersion of the resistance heating element 4 was measured by measuring thickness t of each resistance heating element 4 which appears in the cutting plane.
[0045] Each result is as being shown in Table 1.
[0046]
[Table 1]

測定ポイント	本発明		従来例	
	抵抗発熱体の厚み(μm)	温度(℃)	抵抗発熱体の厚み(μm)	温度(℃)
a	14.3	500	16.2	500
b	14.5	499	15.8	498
c	14.8	498	16.3	501
d	14.9	499	17.3	488
e	14.5	500	16.9	481
f	14.2	501	18.2	485
g	14.5	499	16.9	483
h	14.3	502	14.5	512
i	14.5	500	16.1	507
j	14.3	501	15.0	505
k	15.0	500	14.9	500
l	15.1	504	15.5	499
m	14.8	503	14.7	501
n	14.7	502	13.0	518
o	14.4	505	13.5	515
p	15.0	503	13.2	510
q	14.6	504	13.9	511
r	14.5	505	13.3	508
s	14.6	504	13.7	512
①平均値	14.6	502	15.4	502
②最大値－最小値	0.9	7	5.2	37
②／①(%)	6	1	34	7

[0047] Consequently, in elegance, it turns out conventionally that remarkable dispersion has the difference of the maximum of thickness t of each resistance heating element 4 which appears in a cutting plane, and the minimum value in thickness t of 34% and the resistance heating element 4 to the average of thickness t of the total-resistance heating element 4. For the reason, 37 degrees C and exoergic nonuniformity had the large difference of the maximum and the minimum value in the exoergic side 3.
[0048] On the other hand, it turns out that, as for this invention article, the difference of the maximum of thickness t of each resistance heating element 4 which appears in a cutting plane, and the minimum value can reduce sharply thickness dispersion of 1% and the resistance heating element 4 to the average of thickness t of the total-resistance heating element 3. For the reason, the difference of the maximum and the minimum value in the exoergic side 3 was able to hold down exoergic nonuniformity to 7 degrees C and 20% or less of the comparison article, and was able to raise the temperature distribution of the exoergic side 3 sharply.
[0049] (Example 2) In the ceramic heater 1 of this invention, thickness dispersion of the resistance heating element 4 was made to change intentionally, and the experiment investigated on the same conditions as an example 1 about the relation between thickness dispersion of the resistance heating element 4 and the temperature distribution of the exoergic side 3 was conducted there.
[0050] And since to make the difference of the maximum temperature and the minimum temperature into 20 degrees C or less as temperature dispersion of the exoergic side 3 in recent years was desired, the case of 20 degrees C or less was evaluated as generation of heat being good.
[0051] Each result is as being shown in Table 2.
[0052]
[Table 2]

	抵抗発熱体のばらつき ②／①（%）	発熱面の 温度 ばらつき
1	6	7
2	9	1 3
3	1 2	2 1
4	1 7	2 6
5	2 2	2 8

①：全抵抗発熱体の厚み　の平均値
②：各抵抗発熱体の厚み　の最大値と最小値の差
※は本発明範囲外である。

[0053] Consequently, it turns out that temperature dispersion of 10% or less, then the exoergic side 3 is made by the difference of the maximum of thickness t of each resistance heating element 4 which appears in a cutting plane, and the minimum value with 20 degrees C or less to the average of thickness t of the total-resistance heating element 3.
[0054]
[Effect of the Invention] As mentioned above, according to this invention, carry out addition kneading of a solvent and the binder at the powder of refractory metals, those alloys, or conductive ceramics, and the green sheet for resistance heating elements is manufactured by the tape-forming method. By degreasing, after putting what was pierced to the predetermined exoergic pattern with metal mold between the ceramic green sheets which constitute a ceramic object and forming a green-sheet layered product, and subsequently calcinating The difference of the maximum of thickness t of each resistance heating element 4 and the minimum value in the cutting plane cut by at least two segments of the exoergic pattern space constituted with a band-like resistance heating element which pass along the

central point mostly From having laid underground the exoergic pattern which is less than 10% of the average of the resistance heating element 4 thickness in all cutting planes into the plate-like ceramic object 2, and having constituted the ceramic heater Since thickness dispersion of the resistance heating element which constitutes an exoergic pattern can be made very small, the temperature distribution of an exoergic side can be made uniform. Though plasma will ** under halogen system corrosive gases, such as a fluorine system and a chlorine system, since the resistance heating element is covered by ceramics excellent in corrosion resistance while being able to perform uniform membrane formation and uniform micro processing to a heated object if the ceramic heater of this invention is used as a heater for heating used by membrane formation equipment, the etching system, etc. for the reason, it does not wear out greatly, and it can use over a long period of time.

[Translation done.]

* NOTICES *

MEANS

[Means for Solving the Problem] then, the exoergic pattern whose difference of the maximum of the thickness of each resistance heating element and the minimum value in the cutting plane which cut this invention in view of the above-mentioned technical problem by at least two segments of the exoergic pattern space constituted with a band-like resistance heating element which pass along the central point mostly is less than 10% of the average of the resistance heating element thickness in all cutting planes -- a plate-like ceramic -- it lays under the inside of the body, and a ceramic heater is constituted
[0013] If the above-mentioned ceramic object is especially formed with the nature ceramics of alumimium nitride, the temperature distribution in the exoergic side of a ceramic heater can be made more into homogeneity, and it is suitable.
[0014] Moreover, the process which manufactures the ceramic green sheet of two or more sheets from which this invention constitutes a ceramic object, The process which carries out addition kneading of a solvent and the binder at the powder of refractory metals, those alloys, or conductive ceramics, and manufactures the green sheet for resistance heating elements by the tape-forming method, The process pierced to a predetermined exoergic pattern with metal mold after carrying out the laminating of the green sheet for these resistance heating elements to at least one sheet of the above-mentioned ceramic green sheet, The process which carries out the laminating of the remaining ceramic green sheet, and forms a green-sheet layered product so that the green sheet for resistance heating elements pierced to this predetermined exoergic pattern may be covered, This green-sheet layered product is degreased and a ceramic heater is manufactured from the process calcinated the appropriate back.
[0015] namely, -- according to the ceramic heater of this invention -- a ceramic -- since it is made so small that thickness dispersion of the band-like resistance heating element which constitutes exoergic Pan in the living body cannot be acquired with the conventional screen printing, if a ceramic heater is made to generate heat, the temperature distribution of an exoergic side can be made very uniform
[0016] In order to obtain a ceramic heater with little such exoergic nonuniformity moreover, in this invention The green sheet for resistance heating elements which is hard to deform from a paste plastically is manufactured. a tape-forming method -- a conductor -- Put what was pierced to the predetermined exoergic pattern with metal mold between the ceramic green sheets which constitute a ceramic object, and a green-sheet layered product is manufactured. the state where there is almost no thickness dispersion in the band-like resistance heating element which constitutes an exoergic pattern from degreasing and calcinating this and having manufactured it also in a large-sized ceramic heater -- a ceramic -- it can lay under the inside of the body
[0017]
[Embodiments of the Invention] Hereafter, the operation gestalt of this invention is explained.
[0018] Drawing 1 (a) is the perspective diagram showing the example which used the ceramic heater of this invention as a heater for heating used by the manufacturing process of a semiconductor device, and (b) is the X-X line cross section of (a).
[0019] This ceramic heater 1 is made into the exoergic side 3 for support of the semiconductor wafer W and heating of one principal plane of the above-mentioned ceramic object 2, and has joined the electric

supply terminal 5 for energizing to the resistance heating element 4 to the principal plane of another side of the ceramic object 2 while it lays the band-like resistance heating element 4 underground into the plate-like ceramic object 2 with which the flat-surface configuration carried out the round shape.
[0020] And the semiconductor wafer W supported on the exoergic side 3 is directly heated by laying the semiconductor wafer W in the exoergic side 3, impressing alternating voltage to the resistance heating element 4, and making a ceramic heater 1 generate heat.
[0021] In addition, although drawing 1 showed the example of the ceramic heater 1 to which the flat-surface configuration carried out the round shape, a flat-surface configuration may carry out what configurations, such as what carried out polygons, such as an ellipse form or a square, and a pentagon, addition to this.
[0022] As the quality of the material which constitutes such a ceramic object 2, alumina ceramics, the nature ceramics of a silicon nitride, the nature ceramics of alumimium nitride, the nature ceramics of a boron carbide, etc. can be used. Since the inside of these or the nature ceramics of alumimium nitride has thermal conductivity very high also in ceramics while having the plasma-proof nature which was excellent under the halogen system corrosive gas used by membrane formation equipment or the etching system, they can be suitably used as a ceramic object 2. Especially the nature ceramics of high grade alumimium nitride whose purity is 99.8% or more Since there is almost no grain boundary into a sintered compact and it excels in plasma-proof nature, when a corrosive wear is intense, are the optimal. Moreover, Y2 O3 With the nature ceramics of alumimium nitride contained in 1 - 9% of the weight of the range, rare earth oxides, such as Er Since thermal conductivity has 150 or more W/mk in 100 or more W/mk and a high thing and has 200 or more W/mk in a still higher thing, while being able to raise further soaking-ization of the semiconductor wafer W laid in the exoergic side 4 Time and a cooldown delay until it heats to processing temperature can be shortened.
[0023] moreover -- as the quality of the material of the resistance heating element 4 laid underground into these ceramic objects 2 -- the [, such as a tungsten (W) and molybdenum (Mo), / periodic-table] -- the [, such as 6a group and Ti, / periodic-table] -- 4a group's refractory metals, or these alloys -- conductive ceramics, such as WC, MoC, and TiN, can be used further Even if it makes high temperature generate heat, they are not disconnected, while they can prevent the curvature of the ceramic object 2 and breakage at the time of manufacture and generation of heat, since these metals, an alloy, and conductive ceramics have a coefficient of thermal expansion of the same grade as the ceramics which constitute the above-mentioned ceramic object 2.
[0024] furthermore, as an electric supply terminal 5 for energizing to the resistance heating element 4 in the above-mentioned ceramic object 2 Metals, such as a tungsten (W), molybdenum (Mo), and nickel (nickel), and an iron (Fe)-cobalt (Co)-nickel (nickel) alloy can be used. When especially oxidation resistance is required, it is good to use nickel (nickel) or an iron (Fe)-cobalt (Co)-nickel (nickel) alloy.
[0025] by the way, as an exoergic pattern of the resistance heating element 4 laid underground into the above-mentioned ceramic object 2 Circular resistance heating element 4a arranged so that a concentric circle as shown in drawing 2 (a) may be constituted, in order to heat the circular exoergic side 3 uniformly, It consists of a straight-line-like resistance heating element 4 which connects ****** radii-like resistance heating element 4a, and two edges of circular resistance heating element 4a prolonged in a core are set to electrode takeoff-connection 4c. Since right and left can be mostly made into the shape of isomorphism even if it cuts in such an exoergic pattern S, then which portion passing through a center, the homogeneity of the temperature distribution of the exoergic side 3 can be carried out.
[0026] In addition, what is necessary is not to be limited only to what was shown in drawing 2 (a) as a configuration of the exoergic pattern S, and just to design suitably according to the structure of the ceramic object 2, or the configuration of the exoergic side 3. However, when the exoergic side 3 carries out a round shape like the ceramic heater 1 of drawing 1 , what has a pattern configuration as shown in drawing 2 (b) which has the exoergic pattern S shown in drawing 2 (a) and electrode takeoff-connection 4c in the outermost periphery is desirable.
[0027] And according to the ceramic heater 1 of this invention, it is characterized by the difference of the maximum of the thickness of each resistance heating element 4 and the minimum value in the

cutting plane cut by at least two segments of the above-mentioned exoergic pattern space which pass along the central point mostly being less than 10% of the average of the resistance heating element 4 thickness in all cutting planes.

[0028] The difference of the maximum of the thickness of each resistance heating element 4 and the minimum value in the cutting plane cut by at least two segments of an exoergic pattern space which pass along the central point mostly here that it is less than 10% of the average of the resistance heating element 4 thickness in all cutting planes For example, while four segments passing through the center of an exoergic pattern space cut the ceramic object 2 to eight division into equal parts at intervals of 45 degrees as shown in drawing 3 , and measuring thickness t of each resistance heating element 4 which appears in these cutting planes and calculating the maximum and minimum value The average of thickness t of the resistance heating element 4 which appears in all cutting planes is computed. In addition, on the occasion of measurement of thickness t, the thickest portion is computed as thickness [of the resistance heating element 4] t in each resistance heating element 4. And it says that the difference of the maximum of thickness t of each resistance heating element 4 and the minimum value in a cutting plane has become less than 10% of the average of thickness t of the resistance heating element 4 in all cutting planes.

[0029] thus, from a very small thing, thickness dispersion of the band-like resistance heating element 4 which constitutes the exoergic pattern S from this invention Thickness dispersion of the band-like resistance heating element 4 which constitutes the exoergic pattern S even when the temperature distribution of the exoergic side 4 can be made uniform and it produces exoergic nonuniformity from the problem on structure locally by ****** etc. from a very small thing Resistance can be easily adjusted only by changing the width of face of the resistance heating element 4 in a part with exoergic nonuniformity, and the exoergic nonuniformity of the exoergic side 3 can be controlled easily.

[0030] By the way, first, in order to manufacture such a ceramic heater 1, as shown in drawing 4 (a), the ceramic green sheets 2a and 2b of two or more sheets and ... which constitute the aforementioned ceramic object 2 are formed. What is necessary is just to fabricate by tape-forming methods, such as a doctor blade method, the Czochralski method, a calender, the paper casting method, the paper casting method, and the roll compaction method, after carrying out addition kneading of a solvent and the and producing a slurry, while the ceramic green sheets 2a and 2b and ... add a predetermined assistant component if needed to the aforementioned ceramic powder.

[0031] On the other hand, as shown in drawing 4 (b), the resistance heating element 4 carries out addition kneading of a solvent and the binder to the powder of the aforementioned metal, an alloy, and conductive ceramics, produces a slurry, and forms green-sheet 4' for resistance heating element 4 with uniform thickness width of face for this slurry using tape-forming methods, such as a doctor blade method, the Czochralski method, a calender, the paper casting method, the paper casting method, and the roll compaction method. In addition, what is necessary is to accustom thickness and just to attain equalization by passing between the rolls which have a uniform predetermined gap, when green-sheet 4' is fabricated by the describing [above] tape-forming method and equalization of thickness cannot be attained, or when the thickness width of face t is too thick.

[0032] And the laminating of green-sheet 4' for resistance heating element 4 obtained as shown in drawing 4 (c) is carried out on [of one sheet] ceramic green-sheet 2h among the ceramic green sheets 2a and 2b of two or more above-mentioned sheets, and ... In addition, what is necessary is just to carry out the laminating of green-sheet 4' for resistance heating element 4 to other ceramic green sheets, in laying the exoergic pattern S underground more than two-layer.

[0033] Next, as shown in drawing 4 (d), after piercing green-sheet 4' for resistance heating element 4 which carried out the laminating on ceramic green-sheet 2h with the exoergic pattern S of drawing 2 (a), and the metal mold which has isomorphism-like heights, the laminating of the remaining ceramic green sheets 2a and 2b and ... is carried out, and the green-sheet layered product 8 is manufactured so that the above-mentioned exoergic pattern S may be covered, as shown in drawing 4 (e).

[0034] After performing cutting to the green-sheet layered product 8 and making a flat-surface configuration circular the appropriate back, this green-sheet layered product 8 is degreased, and the

ceramic object 2 which lays the exoergic pattern S underground and becomes as shown in drawing 4 (f) is formed by calcinating at the temperature which can subsequently make various ceramic raw materials sinter.

[0035] And while giving polish processing to one principal plane of the above-mentioned ceramic object 2, setting the field granularity to 1 micrometer or less by (Ra) in center line average coarseness and forming the exoergic side 3 Electrode takeoff-connection 4c of the resistance heating element 4 and a hole open for free passage can be drilled in the principal plane of another side of the ceramic object 2, and it can have the electric supply terminal 5 in this hole by low material, and can join to it, and the ceramic heater 1 of drawing 1 can be obtained by connecting electrically the resistance heating element 4 and the electric supply terminal 5, respectively.

[0036] In this way, since thickness dispersion of the resistance heating element 4 which constitutes the exoergic pattern S is very small according to the ceramic heater 1 of this invention, if a ceramic heater 1 is made to generate heat If it can be made to generate heat uniformly and this ceramic heater 1 is used as a heater for heating used for membrane formation equipment and the etching system in a manufacturing process of a semiconductor device, without producing the exoergic nonuniformity of the exoergic side 3 Since the semiconductor wafer supported to the exoergic side 3 can be made to generate heat uniformly, while being able to form a thin film with uniform thickness width of face or being able to perform micro processing to a predetermined precision Since it has covered with the ceramics the resistance heating element 4 excelled [ceramics] in plasma-proof nature though plasma **(ed) under the halogen system corrosive gas, it can be used over a long period of time.

[0037] In addition, although this operation gestalt explained with the example of the heater for heating used for membrane formation equipment and the etching system in a manufacturing process of a semiconductor device, the ceramic heater of this invention cannot be overemphasized by that it can use for others suitably also as a heater used in various fields, such as heaters for heating, such as a heater for ignition of a burning appliance, and a heating device, measuring equipment.

[0038] (Example 1) The ceramic heater 1 of this invention as shown in drawing 1 , and the conventional ceramic heater were prepared, and the experiment which compares thickness dispersion of the resistance heating element 4 with the temperature distribution of the exoergic side 3 was conducted.

[0039] In this experiment, while forming the ceramic object 2 with the nature ceramics of alumimium nitride of 99.9% of purity, the tungsten was used for the resistance heating element 4. Moreover, the target size of the resistance heating element 4 which constitutes the exoergic pattern S was made into thickness t15micrometer and width of face of 5mm.

[0040] Specifically, addition kneading of a solvent and the binder was carried out to the AlN powder of 99.9% of purity, the slurry was produced, and two or more ceramic green sheets of two or more sheets were formed in the doctor blade method.

[0041] A paste is manufactured. and the former -- elegance -- the powder of a tungsten -- receiving -- the solvent of a terpineol, and an acrylic binder -- addition kneading -- carrying out -- the conductor for resistance heating element 4 -- Carry out a laminating to one sheet of the aforementioned ceramic green sheet with screen printing like the exoergic pattern S which shows a paste to drawing 2 , and a green-sheet layered product is formed. this conductor -- To the powder of a tungsten, carry out toluene at a solvent, it carries out addition kneading of the polyacrylic-acid ethyl at a binder, respectively, and ****** produces a slurry. After carrying out the laminating of what formed the green sheet for resistance heating element 4 in the doctor blade method to one sheet of a ceramic green sheet, What was pierced with metal mold so that it might become the exoergic pattern S shown in drawing 2 was covered by the remaining ceramic green sheet, and the green-sheet layered product was formed.

[0042] And these green-sheet layered products are degreased in nitrogen atmosphere. Subsequently, while forming the ceramic object 2 which laid the exoergic pattern S underground by calcinating at the temperature of about 2010 degrees C, giving polish processing to one principal plane of this ceramic object 2 and forming the exoergic side 3 Two holes which are open for free passage to the resistance heating element 3 with a drill were drilled in the principal plane of another side, and each ceramic heater 1 was manufactured by carrying out low attachment fixation of the electric supply terminal 5 which

becomes these holes from an iron-cobalt-nickel alloy.
[0043] And impressed the frequency of 60Hz, and the alternating voltage of 100V to each obtained ceramic heater 1, the setting temperature of 500 degrees C was made to generate heat, and the skin temperature of the exoergic side 3 was measured by the thermostat viewer. The thermometry point was made into the point of a-s shown in drawing 5 . In addition, the thermometry point checked the exoergic pattern space with the X-ray, and performed it.
[0044] Next, after measuring temperature, four segments (it passes along the measurement point) passing through the center of an exoergic pattern space cut each ceramic heater, and thickness dispersion of the resistance heating element 4 was measured by measuring thickness t of each resistance heating element 4 which appears in the cutting plane.
[0045] Each result is as being shown in Table 1.
[0046]
[Table 1]

測定ポイント	本発明		従来例	
	抵抗発熱体の厚み(μm)	温度(℃)	抵抗発熱体の厚み(μm)	温度(℃)
a	14.3	500	16.2	500
b	14.5	499	15.8	498
c	14.8	498	16.3	501
d	14.9	499	17.3	488
e	14.5	500	16.9	481
f	14.2	501	18.2	485
g	14.5	499	16.9	483
h	14.3	502	14.5	512
i	14.5	500	16.1	507
j	14.3	501	15.0	505
k	15.0	500	14.9	500
l	15.1	504	15.5	499
m	14.8	503	14.7	501
n	14.7	502	13.0	518
o	14.4	505	13.5	515
p	15.0	503	13.2	510
q	14.6	504	13.9	511
r	14.5	505	13.3	508
s	14.6	504	13.7	512
①平均値	14.6	502	15.4	502
②最大値－最小値	0.9	7	5.2	37
②／①(%)	6	1	34	7

[0047] Consequently, in elegance, it turns out conventionally that remarkable dispersion has the difference of the maximum of thickness t of each resistance heating element 4 which appears in a cutting plane, and the minimum value in thickness t of 34% and the resistance heating element 4 to the average of thickness t of the total-resistance heating element 4. For the reason, 37 degrees C and exoergic nonuniformity had the large difference of the maximum and the minimum value in the exoergic side 3.
[0048] On the other hand, it turns out that, as for this invention article, the difference of the maximum of thickness t of each resistance heating element 4 which appears in a cutting plane, and the minimum value can reduce sharply thickness dispersion of 1% and the resistance heating element 4 to the average of thickness t of the total-resistance heating element 3. For the reason, the difference of the maximum and the minimum value in the exoergic side 3 was able to hold down exoergic nonuniformity to 7 degrees C and 20% or less of the comparison article, and was able to raise the temperature distribution of the exoergic side 3 sharply.
[0049] (Example 2) In the ceramic heater 1 of this invention, thickness dispersion of the resistance heating element 4 was made to change intentionally, and the experiment investigated on the same conditions as an example 1 about the relation between thickness dispersion of the resistance heating

element 4 and the temperature distribution of the exoergic side 3 was conducted there.
[0050] And since to make the difference of the maximum temperature and the minimum temperature into 20 degrees C or less as temperature dispersion of the exoergic side 3 in recent years was desired, the case of 20 degrees C or less was evaluated as generation of heat being good.
[0051] Each result is as being shown in Table 2.
[0052]
[Table 2]

	抵抗発熱体のばらつき ②／①（%）	発熱面の 温度 ばらつき
1	6	7
2	9	1 3
3	1 2	2 1
4	1 7	2 6
5	2 2	2 8

①：全抵抗発熱体の厚み の平均値
②：各抵抗発熱体の厚み の最大値と最小値の差
※は本発明範囲外である。

[0053] Consequently, it turns out that temperature dispersion of 10% or less, then the exoergic side 3 is made by the difference of the maximum of thickness t of each resistance heating element 4 which appears in a cutting plane, and the minimum value with 20 degrees C or less to the average of thickness t of the total-resistance heating element 3.

[Translation done.]